DBP: Chlorite Fact Sheet

See related information: Acronyms & Abbreviations; Glossary of Terms and Treatment Technology Fact Sheet, DBP Fact Sheets.

Contaminant Data

ClO_2

Chemical Data Chlorite (ClO_2^-) is a result of disinfection with chlorine dioxide and is a unique concern to only this process. Chlorite is an inorganic ion which is colorless, odorless, tasteless, and dissolves easily in water. Chlorite is fairly stable unless it comes in contact with other chemicals such as free chlorine. MW = 83.45 g/mol.

Source in Nature Chlorite is not typically derived from natural sources. Chlorite is one of the two or three chemicals involved in the process of generating chlorine dioxide for water treatment. Chlorite enters the water when it is incompletely converted to chlorine dioxide. Chlorite is also the byproduct of disinfection with chlorine dioxide, with 70% of the chlorine dioxide converted to chlorite and ~30% converted to chlorate (ClO_3^-) and chloride (Cl^-). Other major sources of chlorite in the environment come from the bleaching of wood pulp by paper mills and the disinfection of municipal wastewater.

SDWA Limits Chlorite is one of four regulated disinfection byproducts (DBPs). The MCL for chlorite is 1.0 mg/L (monthly average). MCLG for chlorite is 0.8 mg/L. Significant monitoring requirements are also included in the SDWA regulations. Chlorate (ClO_3^-), a similar byproduct, is currently unregulated.

Health Effects Exposure to chlorite at levels above the MCL, may have nervous system effects in infants and young children along with fetuses in pregnant women. Chlorite exposure may also cause anemia.

Removal Techniques

Chlorite (and chlorate) control focuses primarily on:

- Reducing the oxidant demand (e.g. NOM removal), and consequential reduction in dosage applied.
- Control of chemical reactions.
- Minimizing exposure to UV and sunlight.

Changing disinfection processes and the removal of chlorite is usually a final solution when other methods can not achieve required reductions.

USEPA BAT
Refer to: Individual Treatment Technique Fact Sheet if available for further information.

- **NOM Removal**
    - Enhanced coagulation and media filtration for NOM removal uses the conventional treatment processes of chemical addition, coagulation, and dual media filtration. *Benefits*: low capital costs for proven, reliable process. *Limitations*: operator care required with chemical usage; sludge disposal.
    - A granular activated carbon (GAC) filter can be used to remove NOM. GAC uses

extremely porous carbon media in a process known as adsorption. As water passes through the media, the dissolved contaminants are attracted and held (adsorbed) on the solid surface. *Benefits*: well established; suitable for home use. *Limitations*: effectiveness based on contaminant type, concentration, rate of water usage, and type of carbon used; requires careful monitoring.

- **Control of Chemical Reactions**
  - A dose of sodium chlorite above the stoichiometric ratio with chlorine can result in unreacted chlorite passing into the treated water stream. In turn, a dose of excess chlorine can result in chlorate formation. Hence, the blending ratios and subsequent mixing should be optimized and rechecked periodically. In addition, chlorate can be formed by a similar conversion of chlorite to chlorate via free chlorine used elsewhere in the treatment process. In this case, the amount and location of free chlorine addition should be examined. Chlorate can also be formed via the photochemical decomposition of chlorine.

- **Minimizing exposure to UV and sunlight**
  - The occurrence of photochemical decomposition of chlorine dioxide can affect the ultimate concentrations of chlorine dioxide, chlorite, and chlorate in water treated with chlorine dioxide. Sunlight may increase chlorate concentrations in uncovered storage basins containing water with chlorine dioxide residuals. Exposure to ultraviolet light will also change the potential reactions between chlorine dioxide and the bromide ion, possibly leading to brominated byproducts.

Alternative Methods of Treatment

- **NOM Removal**
  - Enhanced coagulation and microfiltration (MF) or ultrafiltration (UF) for NOM removal uses the membrane filtration of coagulated NOM. *Benefits*: low capital costs for fairly new, but proven process. *Limitations*: higher operator care than for sand filtration, higher O&M costs.
  - Nanofiltration (NF) for NOM removal uses the membrane to physically separate the NOM from the water. *Benefits*: less operator care than with coagulation and microfiltration, consistent low NOM product water. *Limitations*: membrane fouling, operator care, higher O&M costs than microfiltration, concentrate disposal.
  - Reverse osmosis (RO) for dissolved NOM removal uses a semipermeable membrane and high pressure pump to cause the water, but not suspended or most dissolved solids to pass through the membrane. *Benefits*: produces high quality water. *Limitations*: high cost; membrane fouling, pretreatment/feed pump requirements; concentrate disposal.
  - Lime softening uses $Ca(OH)_2$ in sufficient quantity to raise the pH to about 10 to precipitate carbonate hardness and trap NOM in the process. *Benefits*: lower capital costs; proven and reliable. *Limitations*: operator care required with chemical usage; sludge disposal. pH readjustment needed.

- **Alternate Disinfection Process**
  - When process modifications fail to reduce chlorite levels sufficiently, changing the disinfection process is one option. Changing to free chlorine is an option, however, there are also associated DBPs with this process. Changing the disinfection process to

ozonation is effective in eliminating chlorite, but it is fairly expensive and there is a problem with bromate and other brominated DBP formation in high bromide waters. Switching to UV disinfection eliminates chlorite formation and is less expensive than ozonation. A disinfectant residual using chloramines or free chlorine still needs to be provided in the distribution system for both ozone and UV treatment.

- **Chlorite Removal**
    - Chlorite can be removed by reduction with ferrous iron added to the drinking water; the by-product being chloride. Complete reduction occurs within 3 to 5 seconds at pH 5 to 7. Special consideration should be given to ferrous iron doses as to not exceed the secondary standard (0.3 mg/L) for iron.
    - Adsorption with a GAC filter or powdered activated carbon is another removal technique (see "NOM Removal" section above). However, the capacity of either of these is low with high amounts and doses needed for effective removal.
    - RO is also effective for chlorite and chlorate removal (see "NOM Removal" section above).

References

USEPA BAT (Coagulation, GAC, Optimization)

USEPA. The Stage 1 Disinfectants and Disinfection Byproducts Rule, What Does it Mean to You? EPA 816-R-01-014. June 2001. http://www.epa.gov/safewater/mdbp/stage1dbprwhatdoesitmeantoyou.pdf

USEPA. National Primary Drinking Water Regulations: Disinfectants and Disinfection Byproducts; Final Rule. RIN 2040-AB82. 40 CFR Parts 9, 141, and 142. Section II E. December 1998. http://www.epa.gov/OGWDW/mdbp/dbpfr.html

USEPA BAT (Reaction Control, Minimize exposure to light)

USEPA. Alternative Disinfectants and Oxidants Guidance Manual. EPA 815-R-99-014. Chapter 4. April 1999. http://www.epa.gov/safewater/mdbp/mdbptg.html#disinfect

Alternative Method (Chlorite Removal via ferrous iron and GAC)

USEPA. Alternative Disinfectants and Oxidants Guidance Manual. EPA 815-R-99-014. Chapter 4. April 1999. http://www.epa.gov/safewater/mdbp/mdbptg.html#disinfect

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